

May 2, 2011

eichten@fnal.gov
aomartin@fnal.gov
lane@physics.bu.edu

$W + jj$ Monte-Carlo study

We want to study $W + \text{dijet}$ background generated with ALPGEN + PYTHIA. Specifically, we want to see the variation of the background under different pdfs and factorization scale choices, and compare distributions of events generated w/ ALPGEN + PYTHIA to LO/NLO $W + jj$ generated with MCFM.

Summary

In the region of interest $100 \text{ GeV} \lesssim M_{jj} \lesssim 200 \text{ GeV}$, the ratio of ALPGEN + PYTHIA events (generated with default pdf choice and scale) to MCFM NLO events is slowly varying and close to 1.0. The ratios of ALPGEN + PYTHIA samples generated with different pdf and scale choices is also approximately 1.0 throughout this region.

ALPGEN Events

The $W(\ell\nu) + \text{jets}$ events were generated at parton level with ALPGENv2.13, with the W forced to decay leptonically (including τ) before showering. We impose parton-level cuts: $p_{T,j} > 15 \text{ GeV}$, $|\eta_j| < 2.75$, $p_{T,\ell} > 12 \text{ GeV}$, $|\eta_\ell| < 1.2$, $\Delta R_{jj} > 0.4$, $\Delta R_{j\ell} > 0.4$.

The events are then passed to PYTHIA6.4, where we perform MLM matching. We choose MLM matching parameters equal to the jet cuts: $p_{T,j} > 15 \text{ GeV}$, $|\eta_j| < 2.75$, $\Delta R_{jj} > 0.4$. With this choice, only $W + 2$ or more jet samples can contain the two jets with $p_T > 30 \text{ GeV}$ necessary for the CDF analysis (while $W + 0, +1$ jet samples cannot pass this criteria). Therefore, we generate $W + 2\text{jet}$ and $W + 3\text{jet}$ samples, with the latter matched as a highest-weight sample. In all ALPGEN+PYTHIA distributions, we show these two different multiplicity samples stacked on top of each other.

The default factorization scale for this process is $\mu^2 = M_W^2 + p_{T,jj}^2$ and the default pdf is CTEQ5L. We generated events using the default values, as well as with CTEQ6M pdfs and factorization scale $\mu^2 = 0.25 M_W^2$, M_W^2 , and $4 M_W^2$.

M_{jj} comparison, absolute normalization

The M_{jj} distributions for i) the default ALPGEN $W + \text{jets}$ sample, ii) the MCFM LO and NLO samples, and iii.) the ALPGEN $W + \text{jets}$ sample with the same scale and pdf choice as MCFM are shown below in Figure (1).

To better see the differences between various scales and generators, we next plot the ratio of M_{jj} distributions (Fig. (2)).

M_{jj} comparison, area normalization

Having seen the effect of using different MC generators and different scale choices on the absolute normalization, we now study the variation of the shape. The M_{jj} distributions for our four ALPGEN + Pythia samples (three with CTEQ6M and varying μ , one with default values) are compared below in Figures (3,4). As we only have one set of MFCM plots (for now), these are left out of the shape comparison. In each figure, we show the absolute normalized comparison in the left-hand pane, and the comparison after normalizing all distributions to unit area in the right hand pane. As before, we separate ALPGEN events into inclusive and exclusive $W + jj$ categories

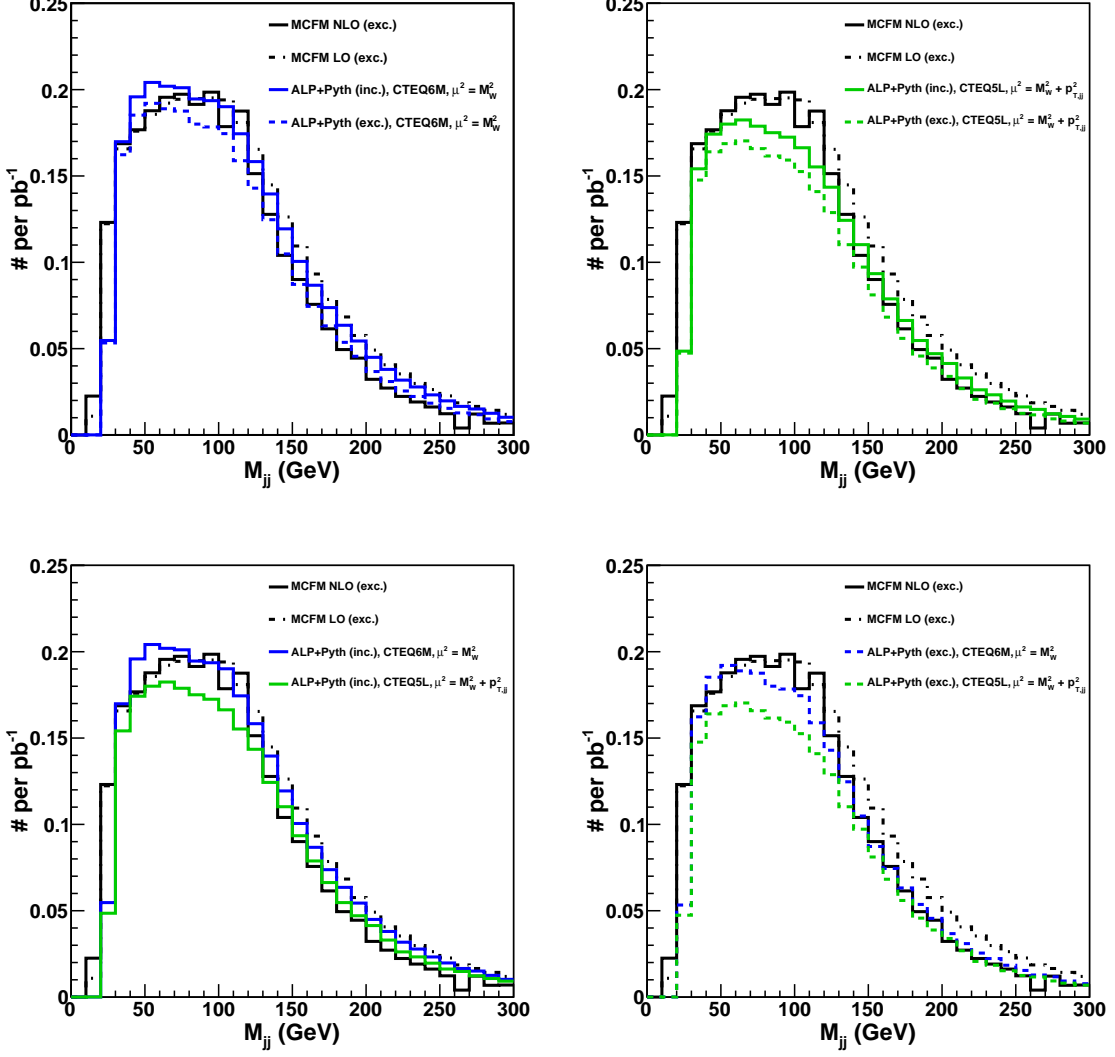


Figure 1: Four different dijet invariant mass comparisons. For the ALPGEN events we actually plot M_{jj} for two sub-samples; plots labeled (inc.) come from $W + \text{jets}$ events with *at least* two jets passing the CDF criteria, while the distribution marked (exc.) comes from events with *exactly* two jets. In the inclusive sample, M_{jj} is formed from the hardest two jets. The ALPGEN events have been generated with two different scale and pdf choices. Only exclusive $W + jj$ MCFM distributions are shown, and were generated using CTEQ6M pdfs and $\mu^2 = M_W^2$.

W+jj : comparing different μ , generators

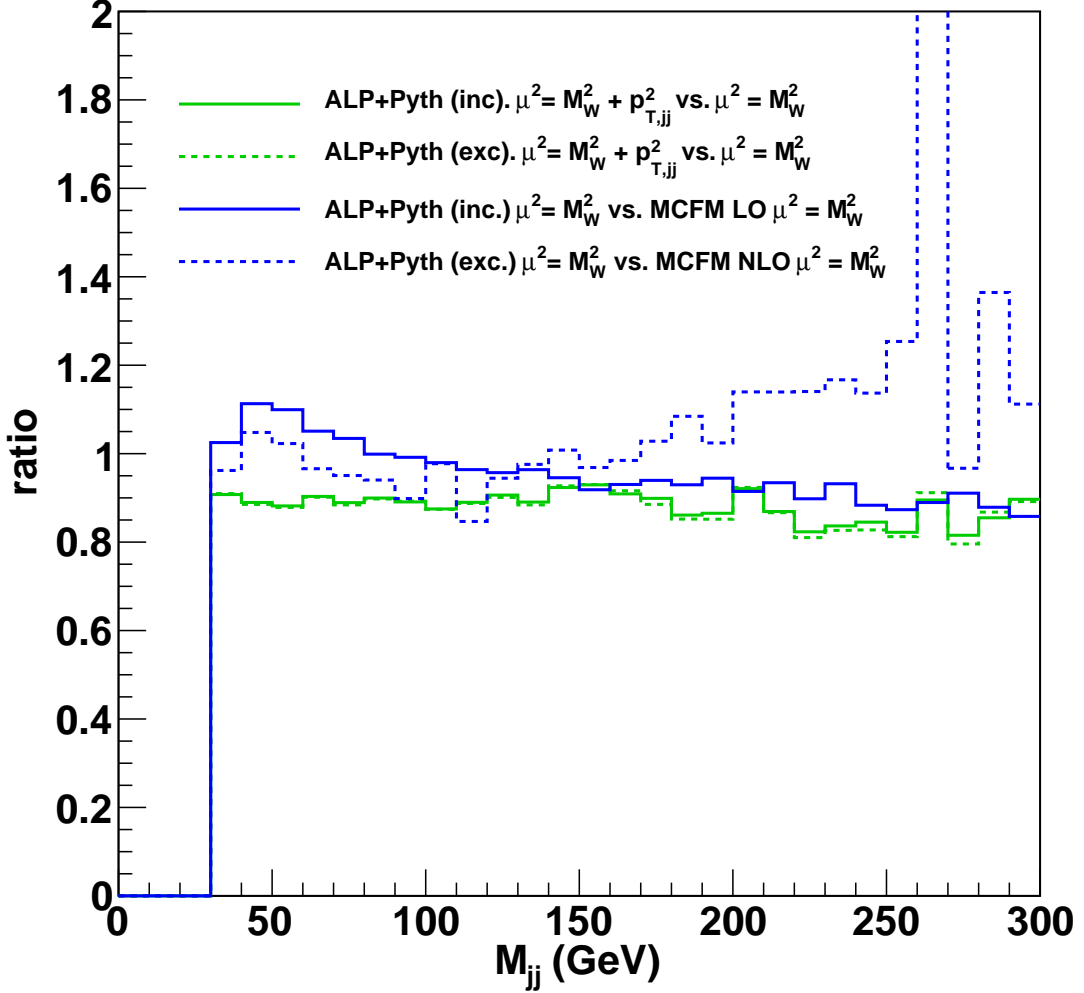


Figure 2: Ratios of the distributions in Figure (1) as a function of dijet mass. The green lines show the ratio of ALPGEN + Pythia events produced with the default scale and pdf choice to ALPGEN + Pythia events produced with CTEQ6M pdfs and $\mu^2 = M_W^2$; solid (dashed) lines indicate the ratios were taken using inclusive (exclusive) $W + jj$ events. The blue lines show the ratio of ALPGEN + Pythia events to MCFM events, where the same pdf and scale choices have been made in both generators. We compare inclusive ALPGEN + Pythia events to LO MCFM (solid), and exclusive ALPGEN + Pythia to MCFM NLO events (dashed). The ratios have been truncated to $M_{jj} > 30$ GeV.

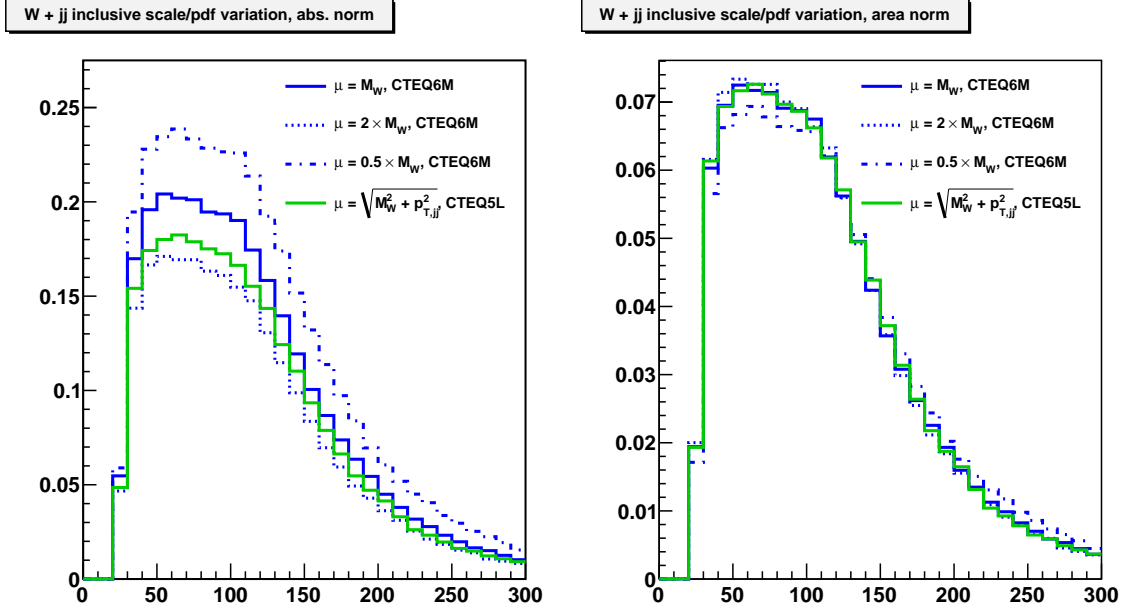


Figure 3: Comparison of ALPGEN $W + \text{jets}$ samples for different scale choices: inclusive $W + jj$ events

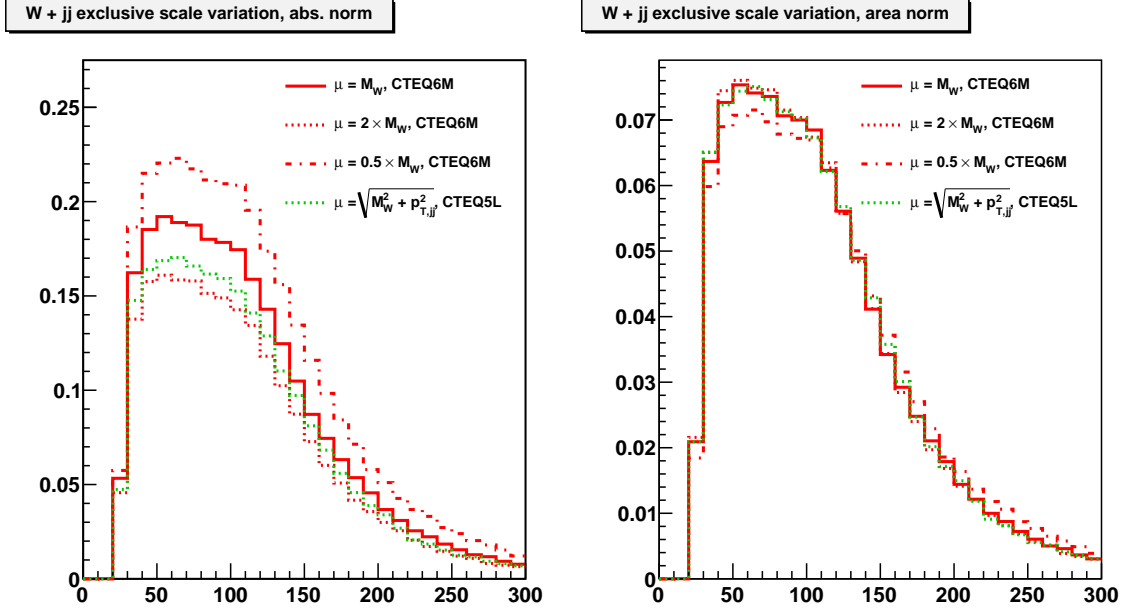


Figure 4: Comparison of ALPGEN $W + \text{jets}$ samples for different scale choices: exclusive $W + jj$ events